Modelling J/ψ production and absorption in a microscopic nonequilibrium approach[*]

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Figure 1: J/ψ-survival probability in p+U reactions at $p_{\mathrm{lab}} = 200$ GeV as a function of rapidity. Calculations with Scenario A (open circles) and Scenario B (full circles) are shown.

We study charmonium production and absorption in heavy ion collisions at the SPS in a microscopic transport approach. Perturbative QCD is applied to the production of charmonium states by simulating nucleus-nucleus collisions in the impulse approximation. The resulting space-time distribution of charmonium production points is inserted into the evolving hadronic environment calculated with the Ultrarelativistic Quantum Molecular Dynamics, UrQMD, model [1]. We compare two scenarios of charmonium production: Scenario A assumes universal and time independent color-octet dissociation cross sections for interactions with nucleons [2] plus comover interactions. Scenario B assumes distinct color-singlet J/ψ, ψ' and χ_c states, evolving from small, color transparent configurations to their asymptotic sizes [3]. The charmonium states (χ_c, J/ψ', J/ψ) are distributed according to their assumed production probability times their decay probability to J/ψ's and according to a parametrized momentum distribution. The charmonium-meson cross sections in both scenarios are obtained by scaling the nucleon absorption cross sections from [3] by a common factor F so that $\sigma(X(c\bar{c})M) = F\,\sigma(X(c\bar{c})N)$. In Scenario A, the nuclear color-octet cross section has been chosen as $\sigma(X(c\bar{c})N) = 4.8$ mb and the comover reduction factor is $F = 1/2$. In Scenario B, $F = 2/3$ while the nuclear dissociation cross sections are all fixed according to the values from [3]. Both scenarios lead to an agreement with the J/ψ data in pA and AB reactions.

Figure 1 shows the rapidity dependence of the J/ψ survival probability in p(200 GeV)+U reactions within the two scenarios. Here, the charmonium absorption is dominated by nuclear absorption. The scenario of a constant c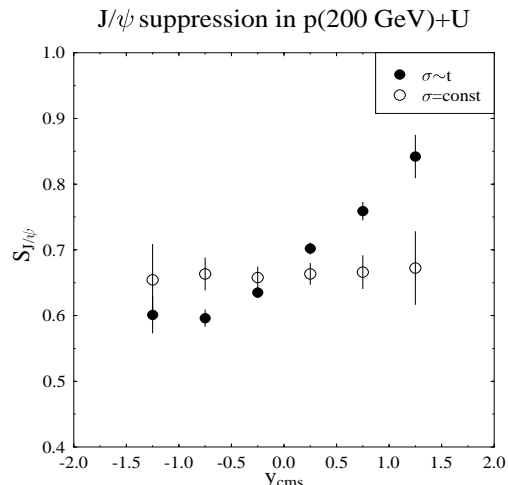olor-octet dissociation cross section leads to a constant rapidity dependence of the J/ψ survival probability because the effective path length of charmonium 'preresonance' states does not depend on their longitudinal velocity. The assumption of evolving color-singlet states results in an increasing survival probability with increasing rapidity because at forward rapidities, the larger γ factor of the charmonium states leads to an increased formation time in the NN center of mass frame. The predicted rapidity dependence of J/ψ suppression can thus be used to discriminate between the two scenarios experimentally.

[1] S.A. Bass *et al.*, Prog. Part. Nucl. Phys. **41** (1998) 225.
[2] D. Kharzeev *et al.*, Z. Phys. **C74** (1997) 307.
[3] L. Gerland *et al.*, Phys. Rev. Lett. **81** (1998) 762.